Physics 311

Homework Set 11

1. A steady current I flows down a long cylindrical wire of radius b. Find the magnetic field, both inside and outside the wire, if

   a) The current is uniformly distributed over the outside of the wire.

   b) The current is distributed in such a way that J is proportional to s^2, where s is the distance from the axis.

2. A thick slab extending from $z = -a$ to $z = +a$ carries a uniform volume current

$$\vec{J} = J\hat{x}. \tag{1}$$

   Find the magnetic field, as a function of z, both inside and outside the slab.

3. Two long coaxial solenoids carry current I_b and I_a, but in opposite directions, as shown in Fig. 5.42. The inner solenoid (radius b) has n turns per unit length, and the outer one (radius a) has ℓ turns per unit length. Find $\vec{B}$ in each of the three regions:

   (i) inside the solenoid,

   (ii) between them, and

   (iii) outside both.

4. A large parallel-plate capacitor with uniform surface charge $+\sigma$ on the upper plate and $-\sigma$ on the lower is moving with constant speed v.

   a) Find the $\vec{B}$-field between the plates and also above and below them.

   b) Find the magnetic force per unit area on the upper plate, including its direction.

   c) At what speed v would the magnetic force balance the electrical force?

5. What current density would produce the magnetic vector potential

$$\vec{A} = k\hat{\phi} \tag{2}$$

where k is a constant, in cylindrical coordinates?